HYDROLOGY REPORT
SANTIAGO CREEK
FACILITY NO. E08
FROM VILLA PARK DAM TO SANTIAGO PEAK

PURPOSE

This addendum to Hydrology Report No. E08-2 (dated September 1987) documents 100-year expected value peak discharges for Santiago Creek and its tributaries at the same concentration point locations shown in the previous report.

GENERAL DESCRIPTION OF DRAINAGE AREA

The drainage area is identical to that described in the 1987 report.

BASIS FOR DETERMINING DISCHARGES

This section is the same as that in HR E08-2 with two exceptions. The critical storm duration at the Villa Park Dam outlet is two days for the 100-year analysis compared to three days for the 500-year analysis. Also, the curve numbers used in determining rainfall loss rates are based on Antecedent Moisture Condition II.

The Villa Park Dam outflow for the 100-year two-day critical storm is 3,500 cfs with no spillway flow when the gated release is 3,500 cfs per the published gate operation schedule. It is not necessary to perform detention basin routing using higher gated release discharges and no Villa Park Dam Outflow Curve (Figure 1 in the HR E08-2) is required.

HYDROLOGY REPORT
SANTIAGO CREEK
FACILITY NO. E08
FROM VILLA PARK DAM TO SANTIAGO PEAK

PURPOSE

This report documents 500-year expected value peak discharges for Santiago Creek (E08), Harding Creek (E19), Williams Creek (E24), Silverado Creek (E17), Ladd Creek (E18), Baker Creek (E16), Black Star Creek (E15), Limestone Creek (E14), Irvine Lake (E08D02), Fremont Creek (E20), Blind Creek (E22), Weir Creek (E21), and Villa Park Dam (E08D01).

GENERAL DESCRIPTION OF DRAINAGE AREA

The 84.1 square mile drainage area is located in northeastern Orange County and western Riverside County. Elevations within the watershed range from 484 feet at the outlet works of Villa Park Dam to 5,687 feet at Santiago Peak. Two important features in the Santiago Creek watershed are Irvine Lake (Santiago Reservoir) and Villa Park Dam. The tributary area to Irvine Lake is 63.7 square miles.

As shown on the Land Use Map (Exhibit 2), much of the watershed is in the Cleveland National Forest. According to the County's General Plan, portions of the Cleveland National Forest are zoned for very low density residential uses; and in Modjeska Canyon and Silverado Canyon there are existing medium density residential uses and some commercial area. However, most of the watershed, inside and outside of the Cleveland National Forest, is not zoned for any development. Table 1 tabulates the assumed ultimate land use for the drainage area.

Table 1

Land Use	Villa Park Dam to Irvine Lake	Irvine Lake to Santiago Peak	Total
Natural	10,280 ac	29,230 ac	39,510 ac
Developed Open Space	2,760 ac	1,275 ac	4,035 ac
Single-Family Residential			
2.5 Acre Lots	17 ac	9,694 ac	9,711 ac
2 DU/Acre	0	383 ac	383 ac
3-4 DU/Acre	0	42 ac	42 ac
5-7 DU/Acre	0	159 ac	159 ac
Commercial	0	5	5
Total	13,057 ac	40,788 ac	53,845 ac

As shown on Table 2, most of the watershed has soil classification D. Soil Group D consists of clay soils and rock outcroppings. It has the lowest moisture infiltration rate of all four soil groups. Only impervious areas (buildings and pavement) have a lower infiltration rate which is essentially zero.

Table 2

Soil Group	Villa Park Dam to Irvine Lake	Irvine Lake to Santiago Peak	Total
A	536 ac	1,283 ac	1,819 ac
B	517 ac	1,000 ac	1,517 ac
C	3,888 ac	11,979 ac	15,867 ac
D	7,699 ac	25,149 ac	32,848 ac
Impervious	417 ac	1,377 ac	1,794 ac
Total	13,057 ac	40,788 ac	53,845 ac

BASIS FOR DETERMINING DISCHARGES

Criteria in the 1986 Orange County Hydrology Manual, with modifications from the 1995 Hydrology Manual Addendum to produce expected value results, were used for this report. The computer program MANNING was used to compute stream flow velocities for travel time calculations. The computer program AES/FLOODOC was used to generate runoff hydrographs and perform channel and reservoir routing.

In order to calculate lag time for the unit hydrograph procedure, the time of concentration (tc) was found using the rational method. Rainfall intensity was reduced for the area and tc at each concentration point so that the discharges used to calculate travel time were close to the final peak discharge obtained by the unit hydrograph procedure. The reduction factors were taken from the Hydrology Manual (Figure B-6 in the Manual).

The Foothill and Mountain S-Graphs were used in the unit hydrograph procedure. The distinction between their use in general is that the Mountain S-Graph characterizes natural channels with numerous plunging flow reaches and lodged boulders. For this report, the Mountain S-Graph was applied to the portions of the watershed above 2,000 feet in elevation. At lower elevations in this watershed, there was not evidence of plunging reaches so the Foothill S-Graph was used. The 2,000-foot demarcation was convenient because it also establishes a change in rainfall intensity per the Hydrology Manual. Table 3 shows the distribution of the watershed above and below 2,000 feet in elevation.

Table 3

Land Use	Villa Park Dam to Irvine Lake	Irvine Lake to Santiago Peak	Total
Area Above 2,000 Feet	2,335 ac	20,332 ac	22,667 ac
Area Below 2,000 Feet	10,722 ac	20,456 ac	31,178 ac
Total	13,057 ac	40,788 ac	53,845 ac

For Weir Creek, Blind Creek, Fremont Creek, and all computed discharge locations above Irvine Lake, the 24-hour design storm was used to generate the discharges. For locations along Santiago Creek below Irvine Lake and at the outlet of Villa Park Dam, a critical storm area and duration analysis was performed. This analysis involves applying a 24-hour storm to the entire watershed and also applying it only to the watershed below Irvine Lake, then comparing the peak discharges. After that, the storm duration is increased one day at a time by adding a day of rainfall to the front end of the storm and applying it to the entire watershed until there is no increase in peak discharge.

For the locations along Santiago Creek below Irvine Lake and at the outlet of Villa Park Dam, the critical storm area was the entire watershed draining to the respective concentration point. Between Villa Park Dam and Irvine Lake, the critical storm duration is two days. At the Villa Park Dam outlet, the critical storm duration is three days. Rainfall reduction factors are always based on the storm area.

Rainfall loss rates were determined after an inventory of the land use/soil group combinations was complete. Land use was based on the Community Profile maps kept in EMA/Planning. They are based on the County General Plan. Soil groups are taken from the same data set as the soil maps in the Hydrology Manual. This data set is from the 1978 Soil Conservation Service Maps. Curve numbers for the natural areas, developed open space, and 2.5-acre lot single-family residential areas are the average of the chaparral, annual grasses, and open brush cover complex curve numbers. The remaining medium density single-family residential areas and commercial areas have curve numbers based on urban covers. It was assumed that developed open space areas would have essentially natural vegetation but some impervious area due to paved trails and miscellaneous buildings. The 2.5-acre lot single-family residential area would also have predominately natural vegetation except immediately adjacent to the residence. All curve numbers were adjusted from Antecedent Moisture Condition II to Antecedent Moisture Condition III for the 500-year analysis.

Reservoir storage data and spillway flow data for Irvine Lake and Villa Park Dam were taken from the Villa Park Dam Operation Manual. Flow rates through the gates as well as operational procedures for Villa Park Dam were taken from the Operation Manual.